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IS THE EIGHT-HOUR WORKING-DAY RATIONAL?[1]

MAY I say at once that it is not my intention to consider the political aspects of the eight-hour problem? There should not be political aspects in a topic that is so preeminently a problem of science. Furthermore, considered as a problem of science, the eight-hour day is rarely viewed in its proper light. In the voluminous literature that has been published concerning it economic and social considerations have been too often paramount. Yet in an adequate analysis of it the real basis of the whole matter is physiological—the eight-hour problem is primarily a problem of physiology; if the physiological effects of any kind of labor are bad, the conditions of such labor ought to be changed. This is fundamental, and should precede any consideration of the economic and social effects of a change of conditions. This basic fact is continually overlooked.

The eight-hour day is the result of an evolution, beginning in human aspiration and fostered largely by humanitarian motives. That baser considerations, the desire to earn wages at the minimum cost of personal effort, impel many advocates of the eight-hour principle, can not be denied, but this need not blind us to the fact that there are higher grounds on which the problem can legitimately be discussed.

In the evolution of the eight-hour day England, of all countries, presents the most interesting history. Diligent search has failed to reveal the origin of the tra-

[1] Read before the Section on Industrial Hygiene of the American Public Health Association, Cincinnati, October 25, 1916.

ditional division of the diurnal twenty-four hours into eight hours each of work, recreation and sleep. It is said that the customary duration of the working-day of the fifteenth century was eight hours. Whether this be true or not, during the subsequent three hundred years all the evils of unrestricted labor flourished vigorously. At the beginning of the nineteenth century most English artisans were accustomed to work from eleven to fifteen hours in the day. No delicate physiological tests were needed to demonstrate what such a system was doing to destroy the vital mechanisms of men, women and children. The results were sufficiently obvious, and the next one hundred years were marked by a series of struggles between workers and humanitarians on the one side, and capitalists on the other, in which progress toward a physiological working-day was gradually, though slowly, made. After sporadic reductions of the working-period to twelve hours or less, a ten-hour movement was succeeded in time by a nine-hour movement, and by the middle of the century the eight-hour day had been definitely proposed. It was won first, not in the mother-country, but by the artisans of Melbourne, Australia, in 1856, and this date marks the beginning of achievement of the eight-hour movement. In the United States agitation in its favor began immediately after the close of the Civil War, stimulated, no doubt, by the great extension of industrial work which then occurred. Thus, since the middle of the nineteenth century the eight-hour day has been the goal of labor. Such a day presupposes one day's rest in every seven and thus signifies a forty-eight-hour week. It is usually coupled, however, with an extra half holiday, which for the majority of persons would be taken on Saturday afternoon. In this manner the week's work would be reduced to forty-four hours, and this represents the present demand of the eight-hour movement. Partly by law and partly by private agreement between employer and employed the eight-hour day has been granted in recent years to one group of workers here and another there, usually localized groups and rarely including all the workers in a single industry of a single country. At the present time it has become legalized in our own country for public employees and employees on public works in the federal service and in thirty states and territories; for miners in the service of fourteen states; for employees in smelting and reduction works in nine states; for railroad telegraphers in six states; for employees in rolling, rod and stamp mills in five states; for employees in tunnels and in coke ovens in three states; for employees in blast furnaces, in cement and plaster mills, and those who work under high air pressure in two states; for employees in electric light and power plants, glass works and irrigation works in one state; and for employees in day's work, unless otherwise stipulated, in nine states. In 1913 of the 1,276,048 employees constituting the shop force of the 51,118 factories in the state of New York, 354,641, or 28 per cent., worked 51 hours or less in the week. The eight-hour day will doubtless ultimately be achieved by a very large proportion of the world's workers in the more highly civilized countries.

What should determine the duration of daily labor? Here I would place, as of first importance, the physiological effects of the work and, as secondary and subordinate factors, its economic and social features.

The physiological effects of labor are now so well known as to require here only brief mention. The expenditure of energy by the bodily organs involves chemical and physical changes in them which, if con-

tinued, leads to the physiological state of fatigue. Fatigue is characterized chemically by the diminution within the acting tissues of chemical substances that have previously been stored within the living cells and either serve as sources of energy or are otherwise essential to tissue activity; and by the appearance within the living cells of other chemical substances, products of katabolic action, which are known as fatigue substances and react upon the tissues to decrease their power of responding to stimuli. If the same amount of work as before is then to be performed by the organs, the nervous system must send to them more powerful impulses, and when this becomes no longer possible the amount of work decreases. Fatigue substances spread from the place of their origin to other organs and react upon them, and thus the activity of one physiological mechanism, such, for example, as a neuromuscular mechanism, fatigues others. In fatigue the senses are less acute; attention is less sharply focused; the power of discrimination is lessened; the muscles are weakened; the quickness and the accuracy of muscular action are decreased; glandular secretions seem to be decreased; the heart-beat may be slowed or, in extreme cases, possibly quickened and irregular; the blood vessels of the skin are dilated and draft an undue quantity of blood away from the brain. In fatigue the sense of weariness obtrudes and oppresses; but it can not be too strongly emphasized or too often reiterated that the feeling of fatigue is a very uncertain index of the presence of a measurable degree of the fatigue of the tissues. The feeling may, indeed, appear just at the time when its warning note is really needed; but it may sound an unduly early and a false alarm; and again, and especially when other potent psychic influences inhibit it, its coming may be unduly postponed. It is a fitful, capricious thing, and this fact is too often overlooked in the consideration of industrial fatigue.

All these physiological changes may be within normal limits, and by rest the irritability of the tissues can then be readily restored and the freshness of sensation and the vigor of mind and muscle can be brought back. But if the work has been too strenuous or too long-continued, if the chemical changes in the tissues have gone too far, or if rest has been unduly curtailed, fatigue passes over into a pathological state which is known as exhaustion and is far less easily recovered from. Not only is the power of achievement then further diminished, but susceptibility to specific disease is increased. There may be a general neurasthenia or other diseases of the nervous system, including nervous affections of the bodily organs. The will may be weakened, and resistance to immoral temptations may be lessened. Intemperance is one of the common results of bodily exhaustion, and even crime itself finds here one of its prolific sources. Resistance to infectious disease may be diminished, apparently because of a diminution of the protective antibodies. Thus, excessive fatigue may bring in its train many disastrous sequelæ with much physical and moral misery. The seeds of this more serious state are often sowed in industrial work, when the conditions of labor and living are such that a residuum of the fatigue of one day is carried over to the next and from day to day there is a cumulative, even if slight, diminution of physiological powers.

Let us develop a little further this topic of the physiological effects of labor. Laboratory experiments have demonstrated that the degree of fatigue of a muscle in a given time varies in accordance with both the amount of the weight lifted and the rapidity with which stimuli are sent to the tissue. Increasing the weight, or making

the muscle contract more rapidly, increases the degree of fatigue in a given time and, if continued, brings on earlier exhaustion. These facts have their counterpart in industrial work, for fatigue here too depends on the intensity and the rapidity of repetition of the individual acts performed by the laborer. In general it may be said that the introduction of so-called labor-saving machinery has diminished the intensity and increased the rapidity of repetition of the laborer's acts. Lifeless machines now often lift the heavy weights once raised by human muscles. Other lifeless machines, intricate and automatic, relieve the laborer of much of his former light muscular work. But these same machines need to be tended by human agencies and set the pace for human activities, and the tendency is ever toward increasing the quickness and the constancy with which sense-organs, brain, spinal cord, and muscles must act.

The introduction of periods of rest while a laboratory experiment with a muscle is in progress diminishes the fatigue of the moment, aids recuperation, and delays the oncoming of exhaustion. This is demonstrated very perfectly in each of us several times in a minute, since each beat of the heart is followed immediately by a resting period of sufficient length to enable the cardiac muscle completely to recuperate from the fatiguing effects of the previous contraction. The beneficial effects of similar resting periods in industrial labor are shown by the custom, not uncommon since the striking demonstration of the late Mr. Frederick Taylor in the lifting of heavy iron pigs, of giving workers occasional brief intervals of freedom from their tasks. The defenders of the twelve-hour duration of work in blast furnaces attempt to justify their attitude by the contention that the workman actually works but a fraction of the whole time on duty. A timely and striking instance of the value of frequent resting periods is reported by the British Health of Munition Workers Committee:

> Two officers at the front recently, for a friendly wager, competed in making equal lengths of a certain trench, each with an equal squad of men. One let his men work as they pleased, but as hard as possible. The other divided his men into three sets, to work in rotation, each set digging their hardest for five minutes and then resting for ten, till their spell of labor came again. The latter team won easily.

Fatigue is modified by the external conditions under which the work is performed. Thus, it was found by Scott and myself that when an animal had been exposed for six hours to an atmosphere with a temperature of 91° F. (33° C.) and 90 per cent. relative humidity the fatigue of the animal's muscles came on more rapidly and their working power was diminished by about one quarter. Certain industrial occupations too require their work to be performed in the midst of excessive heat and humidity and thus afford the conditions of an early oncoming of fatigue and exhaustion. Doubtless other environmental conditions, such as excessive or deficient light, noise, and gross mechanical vibrations, influence the fatigue process, but these have not been adequately and experimentally studied. Attention might here be called to the suggestive little book recently published by the Gilbreths, which shows by what easy and simple means unnecessary fatigue may often be avoided.

It is obvious that if, under any given conditions of intensity and rate of labor and of its environmental features, the working-day is of such a length as to bring about the evil physiological results here mentioned, the surest way to avoid them is to shorten it. There exist few, if any, studies devoted to the specific physiological effects of a reduction of the working-hours, and this gap in our knowledge it is desirable to fill; but that the general health of

laborers has thereby been benefited is testified to by many observers, and this is equivalent, in other words, to an improved physiological status among them.

The economic argument, that industry can thrive only with a long working-day and that any curtailment of it would be destructive, is perennial and has often been potent in discussion. This argument can be met very effectively by pointing to the effects of shortening the working-period on the quantity and quality of output in manufacture. These effects are so uniform that it may be stated as a general law that upon reduction of the daily hours of labor the average quantity of the output of the individual worker undergoes a preliminary decrease, then a return to the original amount, and finally a permanent increase. This augmentation of output occurs, not only with a reduction to ten, but even to eight, hours. Instances of this are numerous. Thus, the very careful study by Professor Abbe of the effects of reducing the working-day in the Zeiss Optical Works in Jena from nine to eight hours shows an average increase of about three per cent. in the daily output of the employees. A certain steel works in England reports that each of its machines turns out in eight hours the same amount of work formerly produced in nine hours. In the steel-sheet and tin-plate trades of South Wales it is stated that after the change from the twelve- to the eight-hour day the increase of output in the rolling-mills amounted to twenty, and in the open-hearth melting process to twelve and one-half, per cent. In the year following the introduction of the eight-hour day into some of the coal mines of South Yorkshire it was reported that the production was "greatly in excess of what was ever produced by an equal number of men when the men worked twelve or thirteen hours." In the mining of bituminous coal in the state of Illinois during the three years previous to a reduction, in 1897, of the working-day from ten to eight hours the average amount of coal turned out daily by each individual was 2.72 tons and during the subsequent three years 3.16 tons, an increase of 16 per cent. The president of a granite-cutting company which had kept for many years a careful record of each employee's work, writes in 1912 that the system

> shows that the same man under identically the same conditions, accomplished more, of exactly the same kind of work when he was working nine hours, than he did when he was working ten hours, and again when the hours were reduced to eight hours this same man accomplished still more in an eight-hour day than he did in a nine-hour day, or a considerable amount more than he did when the day was ten hours long.

A German proprietor of glass-works reports that in a very short time after the reduction of the working-day from twelve and eleven to eight hours "there was produced, without increase of staff, as much as before the reduction"; and a proprietor of glass works in the north of France says:

> I must acknowledge that the men produce just as much, if not more, in their seven and a half hours' actual work than during the ten-hour day that preceded it.

At the Engis Chemical Works near Liége, where a very exact study was made of the results of introducing the eight-hour day, it was reported that

> In an eight-hours' day (seven and one half hours' actual work) the same men at the same furnaces with the same tools and raw material have produced as much as before in a twelve-hour day (ten hours' actual work).

A very significant comparison of the effects of long and short hours was made in connection with the building in the same years of two of our battleships, the *Louisiana* and the *Connecticut*. The *Louisiana* was built at Newport News by a private company working its men ten hours a day; the *Connecticut* was built at the Brooklyn

Navy Yard under the eight-hour system. In a report on the progress of the work during the first nineteen months it is stated by the compiler:

> No other factor is considered than the productive ability of the two bodies of men doing exactly the same kind of work, using the same kind of tools and the same kind of material. It is practically all hand work, as the output of the automatic machines, with their speed limitations in production per hour, does not enter into this work.

The final computation showed that "the average production of a man per hour on the *Connecticut* exceeded by 24.28 per cent. the average production per man per hour on the *Louisiana*."

Thus, the statistics reveal the utter fallacy of the notion that a longer working-day means a larger output. But the greater product of the short day, is, I submit, at first thought a very surprising fact, and its cause should be inquired into. It undoubtedly rests on a physiological basis, but without more accurate data any explanation of it must be only tentative. If man were a mere non-living automatic machine it would not occur. But his is a very different mechanism, in which that portion which does work, the effector machinery, is directed by a nervous system, which acts now consciously, now unconsciously, and through its receptor machinery is being continually influenced by external stimuli. All employers testify to the increased goodwill, better spirit, and improved morale of the workers, that result from the shorter day. Because of these things the workers arrive more promptly at their places and tend to shirk less as the day proceeds. It is not inconceivable that in many cases there is a residuum of fatigue accumulated from the previous longer working-period, which must first be gotten rid of, and that thereafter the effector mechanism is less clogged. It is not improbable that realization of the brevity of the day and the early relief from toil act as a tonic. Such tonics exist: The spurt that occurs during the last hour of labor, irrespective of its length, is a commonly alleged, if not an attested, fact, and is ascribed to anticipation of release. Careful observation has shown too that other psychic influences increase markedly the output of a man's energy. All these varied influences acting upon the nervous system doubtless contribute to increase the expenditure of productive energy in the shorter time. Their combined influence is largely unconscious, and it is reported that the greater output is often a surprise to the workers themselves. That it has an origin largely in the action on the nervous system of such external stimuli as have been mentioned, is supported by the further facts that with the eight-hour day the workman makes fewer mistakes and spoils less material, and, in general, the quality of his work shows a distinct improvement. Thus, in the light of the facts of experience, the alleged economic necessity of the longer working-period because of the necessity of a greater output falls to the ground. The long working-period defeats its own object.

But the question may still be raised whether the greater output of the eight-hour day does not produce correspondingly greater fatigue and thus in turn defeat its object. I do not think so. If the day's fatigue were measured merely by the amount of energy transformed in producing the product, if here again man were a mere automatic machine, then surely there would be a direct ratio—the greater the product, the greater the fatigue, and nothing would be gained. But the case is not so simple as this. The day's fatigue is a sequel not simply of the amount of energy directly transformed in producing the material output. It is derived also from other sources —from the continuance of one bodily position, perhaps a strained position, from the noise and gross vibration of machinery,

from strained attention, from all those minor factors which Abbe has grouped together as sources of his well-named "passive fatigue." A shorter day eliminates these by so much and at its end leaves the worker so much better off than his longer-laboring fellow.

The argument for shorter hours that is most frequently put forward, by labor leaders at least, is the social one. Thus, Mr. Samuel Gompers says:

> The shorter workday is something more than an economic demand. It is a demand for an opportunity for rest, recuperation, development; things which make life more than mechanical drudgery.

This is undoubtedly a legitimate demand, but it in turn is dependent on the physiological requirements of the labor. If a man is worked beyond his physiological limit he is incapacitated for his duties to his family and to society. The history of labor has demonstrated this abundantly, and the experience of reducing the hours of labor has almost universally been followed by marked moral and social improvement, such as is shown by decrease in intemperance and crime, improvement in living conditions, greater efforts toward education, greater intelligence and greater industrial efficiency—all this in contradiction, not only to the vivid predictions of disaster pronounced by active and unprincipled opponents of the change, but to the fears of those who were well-meaning but timid.

As possible factors in determining the duration of labor I might mention the degree of skill required by the laborer and the degree of responsibility devolving upon him. These may rightly be potent in determining the amount of wage to be paid, since they are the accompaniments of greater intelligence and the results of greater training; but in their bearing on the length of the working-day they can be considered, it seems to me, only in the light of their physiological demands on the laborer. If the exercise of greater skill and the possession of greater responsibility deplete his physical and mental powers more quickly, he has earned a shorter working-period. If they do not, I see no reason why he should be granted time privileges.

Let me here summarize. Of the various agencies that have been considered as legitimate factors in determining the length of the working-day that which appears to me the most weighty is the physiological one, the physiological effects of the labor on the individual laborer. In the pursuit of his vocation as the employee of another every human being has a right to the preservation of his physiological powers, to the avoidance of excessive fatigue, to the continuance of his health. All questions of the percentage of financial profit, all questions of social demands or social opportunity, are subordinate to this. Moreover, this is essential to the other considerations mentioned, for only by the preservation of his health can the economic demands of his work be satisfied, only by this can he acquire and maintain skill and be worthy of responsibility. The whole question of the length of the working-day thus rests primarily on a physiological basis. In deciding the length of the working-day, therefore, the first and all-important query is: Is a long day physiologically detrimental to the individual? If so, it should be shortened. If the long day is not physiologically detrimental, then it is a fair question whether, because of his employer's interests or his own relations to society, his day should be long or short.

Is the reduction of the working-period to the eight-hour day a physiological necessity? Here two factors are to be considered: The characteristics of the labor and the capacity of the laborer. Different occupations differ greatly in their fatiguing power. Especially productive of fa-

tigue are those that are characterized by great muscular effort; unusual quickness or complexity of muscular action; single acts, however simple, that are monotonously repeated over long intervals of time; constant strain in attention or bodily position; and those in which the work is carried on in excessively crowded places, in excessive heat and humidity, in the midst of excessive noise, or under other unfavorable environmental conditions.

While different occupations thus differ in fatiguing power, not only in themselves, but in accordance with the external conditions under which the work is performed, there exist also great differences among human beings in their susceptibility to fatigue from a given occupation. This also is paralleled by individual muscles in a familiar laboratory experiment: Homologous muscles from different experimental animals or even from opposite limbs of the same animal, when stimulated at the same rate and lifting equal loads, do not usually perform the same amount of work. In industrial work every observant foreman who knows his men recognizes their individual differences in working power.

Neither the fatiguing effects of the manifold varieties of labor nor the susceptibilities of different laborers to fatigue have been studied with the degree and the care that the subjects demand, and with such paucity of knowledge it seems hardly possible at present to attempt to answer the question whether the reduction of the working-period to eight hours is a physiological necessity. The universality of the beneficial effects of such a reduction, however, argues strongly in favor of an affirmative reply. There has been no more clear-sighted observer and more logically analytic thinker on this topic than the late Professor Abbe, of Jena, in whom the breadth of scholarly culture was combined with a keen sense of efficient business organization. Ten years ago, after carefully analyzing the results of the reduction of the working-day in the Zeiss Optical Works and elsewhere, and considering the general condition of German industries, with their then prevailing long, and English industries, with their short, working-day, Abbe came to the conclusion that by far the majority of industrial workers do not reach their optimum in nine, and do not surpass it in eight, hours. With him the shorter day represents the physiological ideal and the goal for which industries should strive.

I am disposed to agree in general with Professor Abbe's conclusion for the present day. But it is evident, I think, that such a conclusion offers merely a temporary expedient. The establishment of a rigid and universal eight-hour system would probably prove not to be the best for all industries and for all individuals. In order to enable the wisest decision of the question to be made there is needed not mere opinions—not the opinions of employers, however broad-minded or narrow-minded; or of laborers, however industrious or indolent; or of labor leaders, however generous or selfish their ambitions; or of the laity, however philanthropic their motives; or of statesmen, whether they are impelled by a high idealism or by practical politics; but a rigidly scientific study of the question, through the medium of laboratory tests, of the physiological effects of different occupations and the physiological capacities of different laborers and a resultant classification, on a physiological basis, of work and workers. Such a study is not impossible, and it would afford the only basis for a rational and really intelligent solution of the problem. It would doubtless lead to the establishment of no rigid, but an elastic system, in which the work would be adapted to the worker, and the worker to the work. In one industry the duration of labor might be eight hours,

in another it might be more or less than eight hours. So too within a single industry one worker might labor longer than another. Such a solution could be made to satisfy both economic and social demands and lead to the maximum of individual and national efficiency.

I quite realize the difficulties inherent in putting into practise a system which does not recognize the magic eight hours as the ideal, and especially the still greater difficulties in the establishment of a system in which within a single occupation one person works longer than another. But I believe that these difficulties would prove less formidable if we would once get accustomed to the notion that individual capacity is the first criterion to be considered in deciding upon labor's duration. The adjustment of wages according to individual capacity I will leave to the economists.

In view of all this how fatuous was the action of the state of California in voting, in 1914, on the question whether the eight-hour day should be adopted! The proposition was defeated by about two to one, but the decision was necessarily a matter of sentiment, resting on no basis of adequate knowledge. An affair of such serious moment ought not to be decided by uninstructed popular feeling. The recent action of Congress in imposing, after a few hours' consideration, an eight-hour day upon railway employees can hardly be called more sagacious than the action of California. The Adamson bill, however, has little bearing on the general principle of the eight-hour day.

It is obvious that any formal regulation of the duration of daily labor is for those whose daily services are employed by others. By so much as a man rises above this stage he becomes free to choose his own working-time. It is a noteworthy fact that with the world's leaders, in industry, in finance, in professional life, the duration of the daily task is wholly secondary to its accomplishment. They are limited by no eight-, or ten-, or twelve- or sixteen-hour considerations. This indicates why such men become leaders. Laborers can learn a valuable lesson from this fact. The greedy employer who constantly saps the energies of those who are the medium by which he gains his wealth is to be condemned no more than is the "slacker" whose only guiding principles are a minimum of effort and a maximum of wage. Moreover, it is trite to say that the obligation rests upon the laborer that rests upon all men, so to use his free hours as to benefit himself, his family and society.

In conclusion I can not refrain from quoting, with warm approval of their sentiments and of their application to our own country, the recent significant words of Sir George Newman regarding British industries:

> Our national experience in modern industry is longer than that of any other people. It has shown clearly enough that false ideas of economic gain, blind to physiological law, must lead, as they led through the nineteenth century, to vast national loss and suffering. It is certain that unless our industrial life is to be guided in the future by the application of physiological science to the details of its management, it can not hope to maintain its position hereafter among some of its foreign rivals, who already in that respect have gained a present advantage.

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THE CARE OF PAMPHLET COLLECTIONS[1]

THE published articles pertaining even to the most restricted fields of science are scattered through a very large number of serial publications of which only the larger institutions of learning and research are able to possess complete sets. The high cost and large bulk of such series preclude their being owned

[1] Contribution from the Museum of Vertebrate Zoology of the University of California.